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FLOATING SOLAR CHIMNEY

The invention concerns solar chimney that can collaborate with solar collectors and wind turbo generators and form electric power stations working by solar power. Such conventional electric power systems using solar energy, with the method of solar collectors and solar chimneys, are based on the principle of solar heating of air in a solar collector of a large area. The warm air is up-drafting, through a collaborating solar chimney that is based on the center of the collector, to superior layers of atmosphere, acquiring updraft speed, due to the height of the solar chimneys. Part of the thermo mechanical energy of this up drafting current of warm air, via a system of the wind turbines and generators in the base of the solar chimney, transforms into electric energy. The solar chimney in this conventional system is manufactured by reinforced concrete. This has the following consequences:

- High manufacturing cost
- Limited height of the solar chimneys due to technological restrictions from the construction materials and from exterior limitations (earthquakes e.g.)

It is known that the output of such a power station is approximately proportional to the product of the height of solar chimney to the area of the collaborating solar collector. Thus for a given power output from such a solar power station the height of the solar chimney determines the area of its collaborating solar collector.
Information about solar chimneys can be found in the book "THE SOLAR CHIMNEY ELECTRICITY FROM THE SUN", by JORG SCHLAICH, 1995.
The proposed invention aims to eliminate all pre-mentioned disadvantages by increasing, for a given power output, the height of the solar chimney and decreasing their construction cost and the area of the solar collectors and therefore the total cost of the respective power plant of electricity.

This can be achieved if we construct the solar chimney a double wall from durable elastic of balloons or airships, filled with gas He (or other non flammable light gas) that makes the chimneys lighter than air. The lighter than air floating solar chimney can have much bigger height than the corresponding solar chimney from reinforced concrete, while

simultaneously its costs remains considerably lower than the cost of a conventional chimney from reinforced concrete.

The construction of a floating lighter than air chimney is feasible taking into consideration that the solar chimney is used exclusively for the up-drafting of warm air. Thus solar chimney stresses arise from the exterior winds and the Bernoulli pressure from the internal stream of warm air. A clever, simple and inexpensive construction can face these stresses effectively. The modern plastic and composed materials that are used for airships or balloons can be used for such a construction combining light weight and high strength in extreme stresses with long life under any exterior conditions.

The advantages of the proposed invention are very important and indicatively but not exclusively are as follows:

- The height of the floating solar chimney can be unlimitedly increased up to some optimal height that will be determined by the materials, technology and cost.
- The construction cost of the floating solar chimney will be considerably lower than the cost of a conventional reinforced concrete chimney.
- The cross-section of the floating solar chimney can easily be altered with the height for the optimal operation of the solar chimney.
- The area of the collaborating solar collector will be decreased proportionally to the increase of height for the same nominal power output of the solar power station, and consecutively the construction cost of the solar collector will decrease proportionally.
- An optimal combination of the height of the floating solar chimney and the area of the solar collector can be chosen for the achievement of the optimal techno economical result.
- Seismic activity of the region does not influence the construction.

Hence the proposed invention could make the electrical power solar stations with floating solar chimneys economically competitive to other electrical power stations per kW of power of kWh of produced energy.

The proposed floating solar chimney is based on the seat (1.4) shown in figure 1a:

- The Main Chimney (1.1) is composed by parts. This has double wall filled with lighter than air inflammable gas that creates the necessary buoyancy force. This lifting force compels the main chimney to take, without exterior winds, a vertical position.
  - The Heavy Mobile Base (1.2) by which the main chimney is suspended. The total weight of this heavy base is bigger than the total buoyancy of the main chimney. This has a result, without exterior winds, the heavy mobile base to sit on the seat (1.4) of the chimney.
- The folding lower part of the chimney (1.3) which without exterior winds is inside the upper part of the seat.

If exterior winds appear the main chimney (1.1) declines to a balance angle. The heavy base (1.2) supported in the edges of the seat receives also a corresponding declined position and the folding part of the chimney (1.3) that is fixed in the lower part of the Heavy Base, is lifted off and receives this decline, ensuring the continuity of the chimney as it appears in figure 1b.

An indicative way of constructing a floating chimney is presented in the following paragraphs. The proposed way of construction is indicative, because there are several ways in doing so. The proposed construction is based on the idea of developing the main solar chimney with horizontal balloon cylindrical rings (Ring D1, figure 2) from flexible wrapping of balloons or airships (with a average surface density of 0,068 kg/sqm). Each cylindrical balloon ring D1 is filled with gas He (that gives a lifting force under regular conditions 10,36 Nt/m) or other light non flammable gas (e.g. NH_3 with lift force under regular conditions 4,97 Nt/m). The ring has an orthogonal cross-section and valves of fulfillment. The dimensions of orthogonal cross-section of ring D1 depend mainly from the diameter of solar chimney. Each cylindrical ring D1 will be separated from next from durable, in horizontal stresses, supporting ring D2 (figure 3). Rings D2 will be manufactured by pipes of hard plastic or composed materials or aluminum with suitable diameter and thickness. Hence the ring D2 supports balloon ring D1 from compressive forces of deformity. The total weight of ring D2 has to be smaller than the remain lift force of the balloon ring D1. Thus each balloon ring D1 will be able to lift up to any atmospheric height as part of floating solar chimney, lifting together at least one ring D2.

The exterior part of ring D2 will have suitable tips for the fastening of rings D2 between them, with the help of threads of high strength in order that intermediary balloon rings D1 to be under pressure,

The proposed floating solar chimney is a set of independent successive parts which are constituted by a constant number of balloon rings D1 and supporting rings D2. Each part is a compact durable set that can float due to its buoyancy. Each part of the chimney is suspended by at least three threads of high strength by the upper part of the Heavy Mobile Base (1.2), see figure 1a.

Thus each part can receive any declined position imposed by exterior winds without problem. The successive parts of the floating chimney are separated, with a balloon ring D1, full from air from the environment which instead of valve of fulfillment, has a simple aperture or a special valve that allows air to enter and to come out depending on the relative movement of successive independent parts of chimney by variable exterior winds. With this intermediate air rings each part of the floating solar chimney becomes dynamically independent from the rests. The main floating solar chimney (1.1) is the sum of these successive and dynamically independent parts fastened independently to the Heavy Base. This set and every part of it can self float and stand the forces from the Bernoulli pressures by the internal updraft of warm air and the exterior winds. The thickness of balloon ring D1 is sufficient for he satisfactory heat insulation of the internal warm current of air that runs through the solar chimney from the exterior air that has lower temperature.

The main floating solar chimney (1.1) leads to its Heavy Mobile Base (1.2). The Heavy Mobile Base (1.2) is constituted by two rings of equal weight connected between them with exceptionally durable threads with high strength and high modulus, invested with flexible durable plastic films, so that it can receive any decline position while remains attached to the top of the seat of chimney. The total weight of the Heavy Base (1.2) exceeds the overall lift force of the main chimney and forms with this a single set. Under regular conditions the upper ring of the Heavy Base, which is manufactured with bigger diameter than the diameter of the upper part of the seat (1.4), sits on the seat of the chimney (1.4) while the lower ring, that has smaller diameter than the internal diameter of upper part of the seat (1.4), remains inside the seat (1.4) of chimney. By the lower part of the internal ring of the Heavy Base (1.2) is suspended the final folding part (1.3) of the floating solar chimney. This folding part (1.3), type accordion, is constructed in a similar

way as the main chimney, with the difference that the balloon rings D1 that constitute it, instead of valve of fulfillment have a simple aperture (or a special valve) which allows the air of the environment to enter and to come out of them, depending on the decline of main solar chimney. The height of the folding part is calculated so that it can receive the maximum decline of the main solar chimney.

The threads of high strength and modulus, combined with the intermediate supporting rings D2, ensure the strength of this folding part to the forces that it accepts and they do not allow the deformity of its cross-section when it is declined and unfolded. This allows the smooth operation of the floating solar chimney when exterior winds appear that compel the solar chimney to receive a decline angle of balance.

If a floating solar chimney is free, without the presence of exterior winds, will have a vertical position, forced by the net lift force of main chimney's balloon rings D1, (figure 1a). The exterior winds compel the floating solar chimney to receive a decline which the heavy base follows and finally the folding part receives it, as shown in figure 1b. The angle of decline will be the one for which the normal drag force, from the vertical on the chimney component of the wind velocity, is equal to the counterbalancing component of net lift force of floating solar chimney.

In this case the dynamic field of flow of exterior winds facilitates the coming out of hot air at the top of the solar chimney, and consequently facilitates the updraft movement of warm air inside the main chimney.

This action potentially compensates the reduction of active height of floating solar chimneys due to the decline that receives when exterior winds appear. Thus the power output by floating solar chimney can be practically independent of exterior winds.

The appropriate place of installment of this solar power station should be chosen in order that the expected local winds do not exceed some strength for safety reasons. The threads of high strength via which becomes the fastening of the rings D2 between them and the final fastening to the Heavy Base (1.2) can ensure the safe withholding of the floating solar chimney under the most unfavorable conditions of exterior winds even if these do not have practical probability to appear.

DESCRIPTION OF FIGURES

Figure 1a: Floating Solar Chimney in vertical position (without exterior winds).

1.1 Main Chimney

1.2 Heavy Mobile Base

1.3 Holding Lower Part

1.4 Chimney's Seat

1.5 (N-1) the part of the main chimney.

Figure 1b: Floating Solar Chimney in decline.

1.1 Main Chimney

1.2 Heavy Mobile Base

1.3 Holding Lower Part

1.4 Chimney's Seat

1.6 Vector of Direction of wind

Figure 2: Cylindrical Balloon Ring of Floating Solar Chimney (Ring D1).

2.1 Internal Diameter of ring D1

2.2 Width of ring D1

2.3 Thickness of ring D1

Figure 3: Supporting Ring (ring D2).

3.1 Internal Diameter of ring D2

3.2 Width of ring D2

Note: Dimensions 2.1, 3.1 are roughly equal to the dimensions 2.2 and 3.2 respectively.